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Green Technology Innovation Enabling Economic Green Transformation

- Impact Through Green Financial Mechanisms

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Abstract: Given the urgent situation of global climate change, green technological innovation has become a key driver for the achievement of sustainable development goals. Green finance, as an innovative financial solution, provides financial support for green technological innovation through the in-depth integration of policy orientation and market mechanisms. This paper systematically evaluates the effectiveness of green finance in promoting green technological innovation and accelerating the transformation of the green economy and analyzes in depth the implementation effect of green finance policy, its interaction mechanism with green technological innovation, as well as the stability of the green financial market and risk prevention and control strategies. At the same time, there are deficiencies in policy evaluation, interaction mechanism exploration, and market stability maintenance in the field of green finance, and in-depth research and practical exploration should be strengthened, which is of vital significance for promoting the establishment of a sound global green economic system.

Keywords: green finance, green technology innovation, green economy.

1. Introduction

Global warming and environmental degradation have raised global concerns. To cope with these problems, the achievement of sustainable development has become a common goal of Governments and the international community. Among them, green technology (GT) innovation is a key path to achieving sustainable development. However, the high-risk and high-input characteristics of GT innovation often make it difficult for the traditional financial system to effectively support its development. At this point, the importance of green finance (GF) comes to the fore.

At the international level, Europe, as a pioneer in the development of GF, has always been at the forefront of the green bond market in the world. Many European enterprises have raised a large amount of funds for the issue of green bonds to support the development, research, and use of green technology.

At present, academics usually agree that green investing has a favorable impact on fostering GT innovation output. Under the macro perspective, Mahmood uses econometric models and analyses

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through empirical research and finds that there is Granger causality between technological innovation, green openness, and financial inclusion in BRICS countries. Wu uses the spatial Durbin model to comprehensively analyse that the digital economy affects GT innovation and that financial development is an important way to achieve this effect [1]. Zhou further shows that financial technology innovation Effectively all-factor enhancement of real enterprises, the effect of financial technology development on the transformation of real enterprises mainly through the information effect and resource allocation effect two aspects of the role [2]. For the region: Asian countries have large populations and the problem of energy consumption is prominent. To enhance ecological sustainability, the popularisation of financial institutions and GT innovation needs to be emphasised [3]. A series of research results show that GF promotes the research and development and implementation of GT, promotes the green industry's quick growth. At the same time, GF lowers the expense and risk associated with GT innovation while enhancing its efficacy and efficiency through risk diversification and resource allocation optimisation mechanisms.

2. Overview and Development of GT Innovation

2.1. Overview of GT Innovation

2.1.1. Definition of GT Innovation

GT innovation refers to the general term for ideas, behaviors, techniques, and methods that can protect the environment, maintain ecological balance, conserve energy and resources, and promote the harmonious development of human beings and nature, i.e., a series of innovative activities that can reduce pollution, and promote sustainable development of technologies, processes, and products that are generated through scientific research and technology development [4].

2.1.2. The Importance of GT Innovation

GT innovation is crucial to tackling worldwide issues like climate change, resource scarcity, and environmental pollution. This approach not only reduces greenhouse gas emissions, but also supports green and low-carbon economic structures and sustainable societal development. As global awareness of environmental protection increases, GT innovation has become a significant driver of economic development.

There are various methods of GT innovation, including, but not limited to, clean energy technology, energy-saving and emission reduction technology, circular economy technology, intelligent technology, and so on. For example, wind power generating, solar photovoltaic power generation, water energy utilisation, biomass energy technology, etc. are specific applications of GT innovation.

2.2. GF Development and Innovation

2.2.1. The Concept of GF

A narrower definition of green focuses on assessing the state of the environment, determining the green share of financial assets and the priorities to be supported through procedural criteria (e.g., "environmental, social and governance" (ESG) management) and pre-defined industry standards for green industries (technologies) (e.g., environmental preservation, waste management, recycling, and renewable energy). In general, it focuses on the overall objectives analyzes the financial system's sustainability and suggests metrics for gauging its performance, and sets financing criteria in line with the objectives, aiming to effectively and efficiently capitalise on environmental risks, with a focus on the financial system as a whole and macroeconomic stability [5].

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2.2.2. Importance of GF

GF is aimed at guiding the flow providing funds to environmentally friendly sectors like clean energy, energy saving, and environmental preservation, helping the innovative development of GT, and promoting green change in the economic system to accomplish the twin objectives of environmental preservation and economic growth. Therefore, as an important force driving GT innovation, the development and application of GF are extremely important for fostering GT innovation.

3. Impact of Regional GF Development on GT Innovation

3.1. Theoretical Studies

3.1.1. Theory of Financing Constraints

The famous MM Theorem, proposed by Modigliani & Miller in 1958, states that the company's investment decisions are autonomous in a perfect capital market of the firm's financing structure, and that the adoption of debt or equity financing by the firm makes no difference to the firm's market value.

However, the premise of a perfect market is difficult to achieve, and more generally, so there is an information asymmetry between external investors and corporate insiders, and the existence of this gap makes external investors believe that the issuance of new shares by a firm is bad news, and thus external investors will buy risky securities at a lower price than they expect, leading to an raising the price of outside funding and making the price of external and internal finances differ [6]. This type of problem is called the investment cash flow sensitivity problem.

According to the formation, definition, and nature of the financing constraint theory. It can be found that, for the government, its policy release, subsidy issuance, and other behaviors will reduce the disparity in information between investors and businesses by sending signals to the market, which will affect the extent of financial limitations; for businesses, the severity of the financial limitations determines the height of the enterprise's investment costs.

3.1.2. Signaling Theory

Based on the signalling theory, some studies have shown that listed businesses with extensive internal control resources, rapid expansion, and an internal audit department are more likely to disclose internal control assurance reports., in addition, listed companies with refinancing plans also show a higher willingness to disclose [7]. When the government releases green financial policies, for enterprises with stronger green attributes and more social responsibility fulfillment, they will choose to increase the disclosure of their relevant information, to open up the information barriers that exist between internal managers and external investors as much as possible, and to obtain the financial support of the government, the credit support of the banks, and the investment support of the investors, and in this case, the enterprise's ability to raise debt financing will also be improved as a result. On the one hand, from the point of view of enterprises' existing environmental protection behaviours, enterprises with strong green attributes are more likely to openly reveal their environmental data. and release signals of strong environmental capability, to raise the market value as well as revenue capacity of enterprises and acquire low-cost finance. Also, on the other hand, from the viewpoint of enterprises' future environmental protection commitment behaviour, even if the enterprises' existing social responsibility commitment is insufficient and polluting, by sending signals to the market that the enterprises are more likely to make changes in environmental protection, it can reverse the social image of the enterprises, so that the investors have confidence in the social responsibility commitment of the enterprises, and believe that the enterprises will abide by the commitment to strengthen their

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social responsibility commitment under the government's environmental regulation policy to obtain preferential and low-cost financing programmes [8].

Firstly, green bonds can lower the price of corporate funding to alleviate the financial pressure of GT innovation, obtaining interest rate concessions, and demonstrating social responsibility; secondly, it can optimise the debt maturity structure of enterprises by extending the debt maturity period and flexibly allocating funds to enhance the compatibility between the investment cycle of corporate GT innovation and the maturity period of green debt financing to ensure the smooth development of GT innovation activities. Finally, comprehensive and high-quality disclosure of green bond information can improve the information transparency of issuing enterprises.

3.2. Green credit

3.2.1. Rationalising and Optimising the Allocation of Financial Resources

Analyzed from the perspective of enterprise financial resource distribution, the impact of resource distribution of GF on enterprise GT innovation is mainly examined for green credit guidelines, green financial products, green financial invention, and green reform pilot.

GF significantly restricts the funding and investment activities List highly polluting businesses through the application of the investment inhibition effect and the financing penalty effect [9]. It effectively guides the movement of money toward sustainable and ecologically friendly areas and restricts the money going to heavily polluting businesses through the implementation of differentiated green credit policies and the extension of central bank collateral to include green bonds [10]. This improves the credit spreads of heavily polluting enterprises and increases their financing costs, forcing businesses to implement innovative green technology [11]. The better development of GF in the region can radiate and drive the neighbouring regions to actively carry out green R&D activities, which will help to form a good atmosphere for GT innovation. Existing research generally confirms that Finance has a big part in encouraging GT innovation.

However, the traditional financial model is limited by the lack of effective technical means and data-driven quantitative measurement support, which makes it difficult to achieve effective supervision of post-loan funds. This results in the inability to timely track and judge the real use of funds by enterprises and their benefits, as well as the inability to accurately identify and screen high-quality GT innovation projects. Therefore, the contribution of GF to raising the standard of enterprise GT innovation appears to be insufficient, but more incentives for self-interested and strategic GT innovation behaviour of enterprises. It is not helpful for the economy's long-term green development [12].

3.2.2. Green Bond Issuance Reduces Financing Costs

The mechanism of green bond issuance to enhance GT innovation is to reduce financing costs, alleviate maturity mismatch, and improve corporate information transparency.

Firstly, green bonds can lower the budget of corporate funding to ease the financial pressure of GT innovation by reducing transaction costs, obtaining interest rate concessions, and demonstrating social responsibility. Secondly, it can optimise the debt maturity structure of enterprises by extending the debt maturity and flexibly allocating funds to enhance the compatibility between the investment cycle of the enterprise's GT innovation and the maturity of its green debt financing to ensure the smooth development of GT innovation activities.

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3.3. Regional Policy

3.3.1. Impact of Environmental Regulation

From the perspective of environmental control, how it affects the enterprises' GT innovation is analysed around the induced innovation effect of Porter's hypothesis. It is believed that command-and-control environmental regulation can force enterprises to carry out GT innovation and form a reliable guide to the flow of social capital [13, 14].

3.3.2. Intellectual Property Protection for Green Technologies

Intellectual property protection of GT refers to the protection of rights about intellectual property, including copyrights, trademarks, and technologies. It plays a crucial role in GT innovation, not only motivating innovators to protect innovations through patents, trademarks, or copyrights but also preventing others from using or copying these technologies without permission through legal means. In addition, intellectual property protection can help innovators to choose the right partners or use licensing methods to promote their technologies, thereby facilitating the commercialisation of green technologies.

4. Trends and Challenges in Green Innovation Technologies

4.1. Status and Trends in Development

Currently, there is an increasingly urgent global demand for green technologies. China has also made remarkable achievements in GT innovation, such as the rapid development of renewable energy technologies, such as wind and solar power, the construction of green transport and infrastructure such as electric vehicles and smart grids, as well as innovative practices in the fields of green building and GF.

In the future, GT innovation will focus more on systemic, integrated, and intelligent. For example, precise management of energy use and effective recycling of waste will be achieved through technology like big data and the Internet of Things. Concurrently, with the ongoing advancement of policies and the deepening of international cooperation.

First, there are insufficient technical barriers and intellectual property protection. Part of the GT innovation field has a high technological threshold, new entrants find it difficult to break through the existing technological barriers, resulting in fierce market competition. Secondly, the a shortage of talent and the limitation of technology exchange. GT innovation requires high-quality talents with interdisciplinary backgrounds, but the current talent supply is insufficient. Meanwhile, technological innovation requires open technology exchange platforms and cooperation mechanisms, but the reality is that there are barriers to technological exchanges and information blockades, limiting technological cooperation and innovation between different enterprises and research institutions.

4.2. Recommendation

The study presented in this paper leads to the following suggestions:

First, Expanding the scope of green. Actively expanding the scope of green, enriching the mechanism of green financial product innovation, endeavouring to develop corresponding green financial products, and realising the benign interactive development of green industry and GF.

Second, Sound market mechanisms. Initiatives such as improving standards for international cooperation in GF, improving regulatory mechanisms for international cooperation in GF, and strengthening international capacity-building in GF.

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Besides, Exercise governmental functions. Governments should motivate financial organizations to aid in the quick growth of transforming enterprises and projects by, inter alia, strengthening policy guidance and setting up incentive mechanisms, to promote the better development of GF.

5. Conclusion

The interaction between GF and GT innovation is very interactive, jointly promoting the growth and transformation of the green economy. As an accelerator of GT innovation, GF can provide a stable source of funds, reduce financing costs, mitigate maturity mismatches, and enhance information transparency, injecting a strong impetus for GT encouraging business innovation as well as research and development and application of GT through policy guidance and market mechanism, paving the way for the green and low-carbon conversion of enterprises. Paving the way for green and low-carbon transformation of enterprises. At the same time, the continuous breakthrough of GT innovation also opens up a broad room for the growth of GF and encourages the growth and expansion of the green finance industry. This benign interaction not only accelerates green economic growth but also contributes to global environmental protection and sustainable development.

However, there are challenges to the integration of GF and GT innovation, including the assessment of the effectiveness of putting in place green finance policies, the study of the interaction mechanism between the two, and the stability and risk management of the green financial market. To address these challenges, it is necessary to establish a better assessment system, clarify assessment indicators, scientifically assess and verify the effectiveness of the use of environmentally friendly financial policies, and enhance the study of the interaction mechanism between the two, to explore a more efficient support model.

Green bonds, as an important part of GF, possess a noteworthy favorable effect on corporate GT innovation. With technological progress and strengthened environmental policies, the positive interaction between GF and GT innovation will continue to deepen, providing solid backing for the world economy's transition to a green economy. In the future, the government needs to create sensible regulations., provide support, and strengthen the linkage with the market to promote the investigation, creation, and utilization of novel, environmentally friendly technology, and establish the groundwork for achieving the country's green and low-carbon growth. At the same time, given the shortcomings of green innovation technology research in terms of policy synergy and economic incentives, reasonable countermeasures need to be implemented to encourage the advancement of green innovative technologies and supply strong support for sustainable development

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